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THE DEVELOPMENT OF CANADA'S PETROLEUM INDUSTRY

By J. K. O'SULLIVAN*

In the panorama of the Canadian oil industry there are many interesting scenes but among the most important to date is the present picture of exploration in Alberta. The development programme now under way in that province is the second largest of its kind in the western hemisphere and one that has proved to be the most successful ever started in Canada. More than 100 companies, from the small producers to the integrated organizations, are spending millions of dollars annually in a search for oil extending over an area of more than 55 million acres.

The event that touched off this large-scale activity was the discovery of oil on February 13, 1947, at Leduc, Alberta, a small Ukrainian settlement about 20 miles from Edmonton. There have been other finds since that time—at Woodbend, Redwater, Golden Spike, Stettler, Excelsior, Whitemud, and Normandville, and as a result Alberta's proved reserves are estimated at more than a billion barrels with the unproved reserves several times that figure.

The impact of Canada's fastest-growing industry is being felt in every section of the country. Domestic oil, replacing imported crude, is saving an estimated $90 million annually in valuable United States exchange—money which can be used to buy other essential commodities. The development programme is bringing new industries and citizens to Alberta and is enriching the provincial treasury by millions of dollars annually. During the fiscal year ending March 1949, the provincial government realized nearly $12½ million from royalties, rents, and the sale of Crown reserves and there are indications that this

* Imperial Oil Ltd.

amount may be tripled in the next fiscal year. Recently it was reported that the province has received more than $19 million from the sale of leases in the Redwater field alone. Another important feature of this oil development programme is the military security afforded by the existence of large reserves of oil within the country's borders.

While the spotlight is on exploration and development in Alberta, the importance of oil in the Canadian economy has long been recognized. The *per capita* consumption of petroleum products in the Dominion is the second highest in the world, exceeded only by the United States, and almost 25 per cent of the country's energy is supplied by oil. At the same time Canada's oil production is comparatively low. Even with the western fields producing some 60,000 brl/day, the country still must import nearly 80 per cent of its crude oil requirements.

The situation is improving and many outstanding oilmen now believe that Canada, in time, may become one of the great oil-producing countries of the world. Even at this early date, production from the Alberta fields can meet the demand of the prairie provinces and self-sufficiency in oil is again in sight.

The word "again" is used significantly, because in the early days of the Canadian oil industry production from the fields of south-western Ontario was ample not only for local needs but for export as well. In the second period, roughly from 1900-1947, Canada was

oil poor and a mounting demand following the transition from a kerosine to a gasoline economy was accompanied by decreased production. But with the discoveries of oil in western Canada, Canadians can again look forward to a period of oil self-sufficiency.

While this goal is in sight the road to it has not been easy. It is paved with heartbreaks and disappointments, dry-holes, and million dollar failures. But the industry was born and has prospered because there were men who had the courage and determination to keep going—men who were willing to take risks and face the chance of a loss as well as a profit.

In 1951 Canadians, in celebrating the 100th anniversary of the oil industry in Canada, will pay tribute to the enterprise and initiative of a native son.

Early Days

In was in the year 1851—eight years before the drilling of the famous Drake well in Pennsylvania—that Charles M. Tripp of Woodstock, Ontario, recovered oil from the "gum beds," formed by petroleum seepage, of south-western Ontario.

The first oil company to be incorporated in Canada was Tripp's own company—the International Mining and Manufacturing Company—which was granted a charter by the government of Upper Canada in 1854. Asphalt was the main product for several years but by the 1860's with the increasing use of kerosine (discovered by another Canadian, Abraham Gesner in 1852), the demand for oil rose steadily. A number of new companies were formed, including J. M. Williams' Canadian Oil Company (successor to Tripp's firm) which was operating a refinery in Hamilton by 1860.

The infant industry began to grow soon after 1855 and there was a feverish oil boom in the Petrolia area. Canadian petroleum products won international recognition, first at the Paris Exhibition 1855 and again in 1862 at the International Exhibition held in London.

But soon many difficulties were besetting these early pioneers. Proper equipment was hard to transport because of the poor roads into the oil-fields. Consequently, many drillers were forced to use an inferior home-made variety. Petroleum technology, as understood to-day, simply did not exist. Inadequate storage facilities presented a very real fire hazard.

These early producers had to face severe American competition. Then, too, there was the difficulty of eliminating the offensive odour which made Canadian oil unacceptable in foreign markets and unpopular at home.

The challenge was too great for many of the companies, and they disappeared. To keep going, others pooled their resources. One of Canada's major companies was formed in this way when seven small refiners in London (Ontario) and Petrolia pooled their resources and equipment in 1880 to form The Imperial Oil Co. Ltd., a name later changed to Imperial Oil Limited.

By the turn of the century, when the automobile opened up additional uses for oil and the Canadian industry had overcome many of the original obstacles and was in a better position to supply the market, the fields of south-western Ontario were in decline. The Canadian oil industry had entered the second phase.

Second Period

At the beginning of the second period oil imports from the United States were a mere trickle. But with continued expansion the trickle grew to a fast flowing stream, and from 1920 on (when adequate figures became available for the first time) the Dominion was importing more than 90 per cent of its crude oil requirements.

Up until 1914 the American oil companies were able to meet Canadian

requirements. But when war was declared there were alarms in the United States about the inadequacy of their oil reserves and among the conservation measures discussed was an embargo on oil exports.

The Americans did not carry out their threatened embargo, but the possibility of being cut off from oil supplies jolted Canadians out of their state of complacency and the industry into immediate action. A number of refineries were built during the war and individual companies made arrangements to buy crude from other than U.S. sources.

Before 1914 there were sporadic attempts at exploration in Canada. An independent oilman, A. W. Dingman, one of the most colourful men in the industry's history, brought in a well at Black Diamond, some 40 miles south of Calgary, just before the outbreak of war. The well produced wet-gas and was the forerunner of Canada's Turner Valley field.

The war called a halt to any further exploration, but as soon as the fighting ceased the first systematic search for oil in western Canada was launched with large and small companies and independent oilmen participating. They drilled some promising formations in eastern Canada but most of the exploratory work turned to the west and northwest where the geological formations are similar to the great producing areas of the United States.

Along with the explorer and fur trader, these pioneers of the oil industry were assisting in the country's growth and development. They drilled for oil in the western plains and foothills. They pushed into the barren lands of the Northwest Territories and drilled on the banks of the Mackenzie, a short distance from the Arctic circle. They were stubbornly confident that oil was to be found somewhere in that vast expanse of land.

The very extent of Canada's prospective oil-bearing regions (estimated at 475,000 square miles) was perhaps a handicap to its development. In 1919 another disadvantage was the lack of adequate equipment. The aids to exploration which are now taken for granted—the seismograph, gravimeter and the magnetometer — were com-

(An Esso photograph)

An old well, and oilfield employee's quarters, in Turner Valley

pletely unknown at that time and were not in general use in Canada until the early 1930's.

Drilling encountered some success. In 1920 a test well was completed at what is now Norman Wells on the lower Mackenzie River. This well was soon producing 100 brl/day from a depth of less than 800 feet. In 1924 naphtha-bearing gas was discovered in Turner Valley and 1936 saw the emergence of Turner Valley as a major oilfield. But these discoveries, particularly in the light of subsequent discoveries, were relatively small. In addition, the cost of finding them was almost prohibitive because of repeated dry holes. One company alone, in a 25-year period, drilled 134 holes at a cost of some $23 millions without finding a single commercial producing well.

This second period, from 1900 to 1947, saw the expansion of operations in other fields of the industry. For example, refineries which were built or enlarged during the first world war, had their capacities increased more than tenfold.

Another driving force was the acceleration of petroleum technology. The American oil industry was the leader in this field although as early as 1920 a Canadian oil company had established a research department and over the years the Canadian oil industry has won world-wide recognition for its contribution to petroleum development.

All during this second period, the Canadian oil industry followed a programme of expansion and consolidation. While the advancement was overshadowed by the more spectacular developments in the United States, it was nevertheless important and paved the way for the third phase.

Third Period 1947—?

Despite the industry's progress up to 1947, there was still one serious weakness in the Canadian oil picture at the beginning of the third phase. In the ten-year period before the discovery of the Leduc field, annual consumption had risen from 43½ million barrels to 96 million barrels while domestic production continued to decline despite every effort by the oil industry to find new reserves. The situation was particularly acute in the prairie provinces where oil had to be imported from as far afield as Texas and New Mexico. The extra distance added to transportation costs and increased the price of the finished products.

After the second world war the supply situation was aggravated by three factors—increased farm mechanization; a growing demand for heating oils; and the country's industrial transformation. Canada's industrial growth is revealed in statistics for the years 1938 and 1947. In 1938, the last full pre-war year, the gross value of industrial production in the Dominion was approximately $3.3 billion while the gross income of farm operations was around $900 million. In 1947 the corresponding figures were $10 billion and $2.2 billion.

The situation was beginning to look desperate when oil was discovered at Leduç one morning in February 1947. Leduc was followed by other discoveries which appear to be ending the long period of oil hunger.

The Alberta Government has taken an active interest in the province's oil discoveries and developments. Conservation measures have been enforced since 1938 at which time a petroleum and natural gas conservation board was set up to protect the oil reserves and prevent waste. Waste was defined for the first time in an Alberta statute to include production in excess of market facilities and demand, as well as waste from an engineering point of view.

Alberta legislation in regard to leases of Crown property is designed to increase the province's potential production and to enable as many companies as possible to participate in developing the oil resources. For example, to maintain

(An Esso photograph)

Part of the crude topping and coking unit at the Sarnia refinery of Imperial Oil Co.

a Crown reservation in good standing, work must be done in every three-month period and at the end of two years, at the very latest, drilling must be started.

Then, if a discovery is made, half of the Crown mineral rights in the township normally revert to the provincial government which in turn sells the leases to the highest bidder. Recently, one company bid and paid $3,232,000 for a lease on 640 acres in the Redwater area.

These Crown leases, whether purchased at auction or acquired by the discoverer of oil under the original reservation, carry a one-year drilling obligation and a continuous drilling clause. Similar regulations are incorporated into the leases granted by the Hudson's Bay Co., the C.P.R. and other private holders of mineral rights.

Oilmen are enthusiastic about Alberta's petroleum future. One of the most promising signs to continued discoveries in that province is the similarity of its geological formations to those of highly productive regions in the United States.

The major oilfields in the United States are to be found in the great interior plains which cover some 1,400,000 square miles in the central part of the country. In Canada this area covers some 475,000 square miles, embracing most of Alberta, and a large part of Saskatchewan and the Northwest Territories. Hence the Dominion possesses a prospective area a third the size of that of the U.S. To the end of 1947, U.S. production and known reserves totalled 60 billion barrels.

Alberta's more than 1000 producing wells already have a potential production of 100,000 brl/day. Sufficient oil has now been discovered to meet the requirements of the prairie provinces for many years to come and the immediate goal of meeting prairie demand of between 65,000 and 70,000 brl/day was achieved in 1949.

Although the main exploration activity is in Alberta, oilmen are testing other possible locations and more than 100 million acres are now under exploration permit or lease from coast to coast. Exploratory wells are being drilled in the Gaspe Peninsula, southwestern Ontario, Saskatchewan, and British Columbia as well as in Alberta. Vast sums of money are being spent in this country-wide search for new reserves. In 1948 oil companies spent some $50 millions on exploration and development and expenditures were expected to reach $100 millions for 1949.

With the search for new fields, the development of existing ones continues at a steady pace. There is a small oilfield in New Brunswick from which 425,000 barrels of oil have been produced. Ontario has the largest number of wells drilled, some 18,800, but in the nearly 100 years of existence, these fields have produced only about 30 million barrels. less than one-third of Canada's current annual consumption. Production in 1948 barely reached 175,000 barrels, but two oil and gas fields discovered in 1949 increased the production figure for that year.

Oil production in Saskatchewan has been increased considerably in the last few years and amounts to about 847,000 barrels a year. Total production to date is over 3 million barrels. This production is of heavy oil and comes entirely from the Lloydminster field on the boundary between Saskatchewan and Alberta.

Alberta production, amounting at the end of 1949 to over 117 million barrels, has come largely from the Turner Valley field, which has had a declining production since 1942 when it reached 10 million barrels. Since its discovery, Turner Valley has produced about 100 million barrels of crude oil and natural gasoline and oilmen say it still holds another 25 million barrels. The decline of Turner Valley has been more than compensated by the new Alberta fields which now have recoverable reserves estimated at over one billion barrels.

There is at present no oil production in Newfoundland, Nova Scotia, Quebec, Manitoba or British Columbia.

There are two other areas in Canada that have large reserves of oil but are uneconomical to develop under present conditions. These are the Norman Wells field in the Northwest Territories and the Athabaska Tar Sands, about 250 miles north of Edmonton.

Norman Wells has produced some 2.8 million barrels of oil to the end of 1948 and has proved reserves of 30 million barrels. In the second world war, this field supplied the war-born Canol project with crude oil and during the last six months of operation it was yielding more than 4,000 barrels per day from 61 producing wells. Lack of markets and high transportation costs have since restricted output from Norman Wells and the field is currently producing less than 700 barrels per day to satisfy local requirements, mainly of the mining industry.

The Alberta tar sands are one of the oil wonders of the world. Conservative estimates place reserves at from 100 billion to 300 billion barrels of petroleum in a 10,000 square mile area. Even the lower figure is startling when it is remembered that the total proved reserves of the world are less than 100 billion barrels.

At the moment, oil from tar sands is not competitive with oil obtainable from flowing wells, for the sands must be mined and the oil extracted at great expense. In addition, the cost of

(An Esso photograph)
Leduc Well No. 2

refining the heavy crude would be extremely high. However, most oilmen are confident that a commercial process will be developed in time as a result of the investigations now underway and in the meantime Canadians can take comfort in the knowledge that such large reserves of oil exist within the country's borders.

Another great Canadian resource is natural gas. The proved and probable natural gas reserves of western Canada now stand close to seven trillion cubic feet. Since a trillion cubic feet of gas will supply a market of 100 million cubic feet daily for a period of 27 years, these reserves are substantial and there is every reason to believe that they will be doubled or even tripled within the next few years.

While the future of the Canadian oil industry is promising, a great deal of work remains to be done. Two important tasks face the industry in the immediate future. The first is to increase the country's proved reserves of oil and the second is to provide cheap transportation for this oil. To do this, Canadian oil companies must raise sufficient capital for the necessary expansion. Joseph Pogue, formerly of the Chase National Bank has estimated that it will take nearly a billion dollars to bring the Canadian industry's production up to the country's anticipated requirements a few years from now of 400,000 brl/day. Part of the money will come from earnings ploughed back into the business but the great need is for more risk capital.

The industry's commitments to search for new oilfields and to expand transportation facilities, apply specifically to Alberta which is the most promising oil region in Canada. Both these undertakings are interdependent and simultaneous.

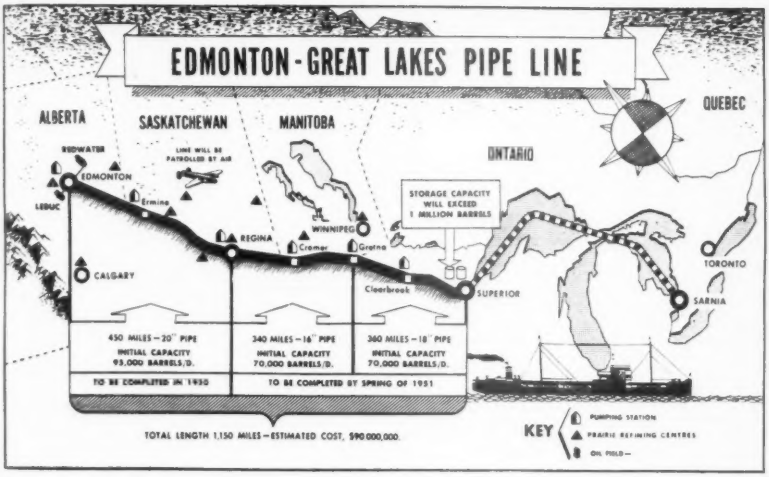
With the present proved reserves in Alberta of one billion barrels, the oilfields could produce upwards of 100,000 brl/day at the rates approved by the province's conservation board. But they are being curtailed to between 65,000-70,000 brl/day because of lack of low-cost transportation and refining facilities. At the same time, to ensure continuing supplies for Canada over a period of time, it has been estimated that reserves of at least two to three billion barrels are needed. For this reason the search for new oilfields is of paramount importance.

As has already been noted, the search for new reserves is being pressed vigorously in western Canada. In Alberta there are 50 rigs drilling in untested territory and an equal number are engaged in development drilling. There are some 68 seismic parties and nine gravimeter parties in operation. But many thousands of wells must be drilled to determine adequately the province's reserves.

Past experience in Canada has shown that it is necessary to drill an average of 35 wells for each oil discovery. In recent years the figure has dropped to about 20 wildcat wells for each discovery. The amount of exploratory work yet to be done in Alberta is staggering. Less than 2,000 wells have been drilled in that province during the entire history of the Canadian oil industry as compared with the nearly 20,000 wells drilled in south-western Ontario, an area which has always been less significant in size and prospects.

The deterring factor to more wildcat drilling is the amount of capital involved. While costs of drilling wells vary—a well might run over a million dollars including exploration and development expenses—the usual cost of drilling and completing a well in the Leduc field, where the preliminary exploration work has been done, is about $100,000.

While the search for oil is continuing, present production in Alberta has reached a saturation point and no further benefits can accrue to the country without additional markets.



But new markets are out of the question until cheap transportation is available. In this respect the oil industry faces the same problem as other western industries—how to overcome the obstacle of distance.

To reach the larger markets of the east, Alberta oil must move more than 1000 miles overland and then by tanker and yet be sold at a price competitive with oil from more accessible areas. At the same time, Alberta producers must realize a reasonable return. This is important because it is necessary to encourage the investment of risk capital needed to find new oilfields on the prairies and the large sums required to develop the fields once they are found.

The price received by the Alberta producer for his crude will be the price at which it must sell in the new eastern markets, less the amount it costs him to transport his oil to those markets.

The lower the transportation costs to new markets, the better the competitive position of western Canadian crude oil, the wider its potential new markets and the greater will be the benefit to the overall Canadian economy.

For these reasons, a pipeline—cheapest form of land transportation of oil—is being built from Edmonton to Superior, Wisconsin, to provide the necessary outlet for Alberta oil.

At present, Canada has less than 200 miles of pipeline within her borders, as compared with a total pipeline mileage in the United States of 409,000 miles—enough to circle the world 16 times.

The 1150-mile pipeline from Edmonton to Superior, now under construction will be one of the longest in the world and will cost about $90 millions. It will have an initial daily capacity of 95,000 barrels from Edmonton to Regina and 70,000 barrels for the remainder of the distance to Superior. By doubling the number of pumping stations, these capacities would be raised to approximately 150,000 barrels and 103,000 barrels respectively. The pipeline will also serve prairie refineries along the route.

The pipeline will follow an all-Canadian route as far as Gretna, Manitoba, and then will cross the border into North Dakota and run an additional 360 miles to Superior, Wisconsin.

By following the southerly route, an initial outlay of $10 millions will be saved and an estimated $400,000 operating costs annually.

The Interprovincial Pipe Line Co. will be responsible for the pipeline which will operate as a common carrier under the Board of Transport Commissioners. When it is completed, the pipeline will mean an additional saving of some 40 million U.S. dollars annually at the scheduled initial rate of flow.

Price reductions made last year cut the prairie consumers' annual bill for gasoline, tractor distillates and other fuels by some $9 millions. Further reductions in prairie product prices may be expected as Alberta oil moves out to more distant markets in the course of the next two years.

All these factors help to explain why the Canadian oil industry places so much importance on the pipeline to the east. That line must, as quickly as possible, relieve the pressure in Alberta and must do it in a way that will bring the maximum benefit to the producers at one end and the consumers at the other. Oilmen feel that anything that reduces its efficiency will place a handicap on the healthy development of one of Canada's most promising natural resources. On the other hand, if nothing impedes its progress, the pipeline can usher in a period of even greater expansion and development.

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PROCESS INSTRUMENTATION COURSES

Courses in process instrumentation have recently been initiated at the University of Leeds. The course, which will ultimately be taken by all degree and post-graduate diploma students in the subjects of gas and chemical engineering, ceramics and process metallurgy, is in two parts. The first part is "The Measurement of Process Variables" and deals with principles and methods of measuring such quantities as pressure, temperature, fluid flow, etc. The second "Automatic Control" deals with the theory and practice of automatic controls as applied to the process industries.

These lecture courses, in common with other lecture courses in the University, are open to external students by arrangement with the Department of Extra-Mural Studies. Enquiries should be made to the Department of Coal, Gas and Fuel Industries with Metallurgy, The University, Leeds, 2.

SIR JOHN CASS COURSES

Refinery Practice

A course of seven evening (6.30 p.m.) lectures on petroleum refinery practice on Thursdays, commencing on January 11, are to be held at the Sir John Cass College, Jewry Street, London, E.C.3, under the chairmanship of R. B. Southall. Individual lectures will be given by P. F. Ellis (general), C. V. Hill and H. Jagger (petroleum fuels), J. A. Jamison (lubricating oils and waxes), A. W. Jarman (bitumen), and W. Pratt (engineering).

Distillation

Commencing on January 12, there is also a course of eight Friday evening (6 p.m.) lectures on distillation by G. A. Dunnett, which covers theory, plant design, and processes.

Fee for the refinery course is 15s. and for the distillation course £1, and enrolment forms may be obtained from the Principal of the College.

OPERATIONAL RESEARCH*

By R. E. STRONG†

Origin and Development

The formal definition of operational research is "The study of executive affairs by the use of scientific method." Recounting the origin of the name may make the definition clearer. Just before the last war, when radar was being intensively developed, the problem of its most effective use was realized to be a big one. Even in its earliest forms, radar was a far more powerful means of detection of aircraft than anything that had been previously conceived. Two sets of people realized the problem most acutely: the Service chiefs, responsible for the operation of fighter defences in war, on the one hand, and the scientists, responsible for the technical development of radar itself, on the other. Between them they came, in time, to a decision which in its way was historic. A small group of scientists was detached and was specifically charged with studying the professional Service problems, as distinct from the technological ones, with studying them in a scientific way, and with advising the Service chiefs direct. Perhaps it is stretching an analogy a little but some of the mathematical aspects of the interception problem were not unlike those in atomic physics or reaction kinetics, in that it was desired to make the probability of effective "collison" between two types of moving particle in three-dimensional space as large as possible, when only some of the factors were known and fewer could be brought under control. In the Services everything must have a label. "Scientist" is almost synonymous with "research." "Operations" has its obvious meaning. Therefore it was not surprising that the work of this group became known as "operational research." The features of this first set-up may be briefly noted. Scientists were advisory, they studied operations, they used statistical methods.

The subject and, perhaps, also its nice name, attracted a good deal of attention in the Services, especially after the battle of Britain had demonstrated the value of several of the earlier studies. Similar sections began to be developed elsewhere than at Fighter Command. In 1941, when P. M. S. Blackett was heading the Section at Coastal Command, Operational Research received the dignity of formal recognition of its name. Coastal Command, in a sense, formed a link with the Navy and though it is chronologically in the wrong order, the next example of operational research is a Naval one.

In 1943, the resources of both sides in the battle of the Atlantic were stretched to the full. New ships, new weapons, were on the stocks but there was no chance of their coming into effective use for many months. Meanwhile the number of variables that could be controlled was small. One of them, however, was size of convoy. Ever since 1917 it had been, in Naval circles at least, somewhat of an open question as to whether ships in large convoys were, in general, safer than in small. The new Naval Operational Research Section undertook a study of sinkings since 1941. They found, as a probability that the number of ships *per voyage* sunk in convoy was about the same in large convoys (over 45 ships) as in small, and that, broadly speaking, other things, such as chance of interception of a convoy, were about equal.

The net result was that ships in large convoys tended to have lower *percentage* sinkings. In other words, the Naval dispute was, for the moment, answered

* An Address delivered to various branches of the Institute.

† "Shell" Refining and Marketing Co.

in favour of the large convoys. Physical explanations were still conjectural but the statistical probability was high enough for the Admiralty to decide on a policy of large convoys; a policy which soon paid dividends. As a matter of interest, the most plausible physical explanation was the fact that a U-boat had a limited supply of torpedoes. Once it had managed to penetrate a convoy's screen, the U-boat was in the position of having more targets than ammunition, so that the damage it did could not exceed a certain fairly small figure. The features in this example are seen to be roughly similar to those in the radar one, with the notable exception that instead of being aimed at making the best use of a new weapon, operational research here was concerned with making better use of existing resources. This feature nowadays almost characterizes operational research.

In the Army the first application of operational research was, as might almost be expected, in anti-aircraft. In 1941 and 1942, Blackett and Schonland, the South African physicist, developed the use of recording vans. These were small tradesman's-type delivery vans, equipped inside mainly with a bank of receiver dials capable of being photographed at intervals. Their function was to go out to gun sites likely to be involved in an engagement and to record information during any shoot. The dials were tapped in to the normal transmitters, passing angle and range, etc., data at each link in the radar-predictor-gun chain of information. During an engagement they were photographed every few seconds and when the guns fired. By rather tedious analyses of their readings one could then work out the most probable position of an enemy aircraft at short intervals of time, smooth these out into a most probable course, calculate the most probable position of each burst and so get quite accurate information on how guns, crews and general "gubbins" were behaving. This information was then applied both to the technical development of better equipment and also to the training of gun crews and radar operators. It played a large part in reducing the 40,000 "rounds per bird" needed in 1940, to the figure of 200 or so needed for a flying bomb in 1944. We may note in this example a new feature. The advisory status, statistical methods, getting the most out of existing resources, are still there but added now is a data-collecting organization, including some special research apparatus.

The difficulty of collecting accurate data, in fact, proved the biggest headache to operational research in the Army. The Army's fighting unit in the field is not a ship or an aircraft, whose behaviour, within limits, is both known and reproducible, but the private soldier, whose behaviour is not—at least it is much less so. Army field actions, in other words, are apt to be much more a series of unique events than naval or air ones and more poorly reported at that. Nevertheless scientific method had its uses outside the field of anti-aircraft. One of these was found in the design of large artillery bombardments. Casualty data and operational reports (some of which went back to 1917) showed that a bombardment density, at or above a certain weight of high explosive per square yard put down on a field target in the space of two or three hours, seemed to induce in defenders, no matter how high their morale or training, a kind of moral overwhelming in addition to the actual physical casualties. Physical casualties, in fact, could be calculated and seldom turned out to be more than about 15 per cent, depending on the type of ground and cover. The overwhelming effect wore off, especially with trained troops, in the space of a few hours, but during that time the success of a normal infantry attack on the target was almost certain. The great bombardments of D Day and later were designed on this basis.

An interesting, if slightly irrelevant, sidelight on Army Operational Research comes from Burma. At one time a large allied defensive position was set up more than 200 miles behind the Japanese "lines." The Japs brought up artillery, which had never been used in that theatre before on any scale. However, an Operational Research officer who happened to be attached to the Brigade, worked out, using data just sent him from Europe, that all the Jap guns at their worst could not put down anything like the critical weight per square yard and that the highest probable number of casualties per day was only sixteen. This information was a distinct relief to the Brigadier, although he hardly believed it. Shortly after, the guns opened up, and the first day's casualties were twelve. The Ops Research officer kept quiet about the many doubtful premises in his calculations. The point of this anecdote, however, is to illustrate what is often called the "operational research outlook," in this case to reduce everything to statistical probabilities whenever possible.

Before leaving the Services it is worth while to have a look at a brief example in civil defence. Most ex-air raid wardens will remember, without much regret, the complicated information that had to be given about every bomb, exploded or unexploded, that had been dropped. This information was used for a kind of operational research, whose data-collecting organization was based rather oddly, on the Cement and Concrete Association. For example, suppose an unexploded bomb dropped near a railway line. The first report could tell only the size and position of the hole. From this, however, it was possible to work out the probable pattern of the bomb, the probability of its exploding and, from a knowledge of traffic density on the line, the probability of its wrecking a train. As fresh information came in, the answer could be continually revised. The point is, that from the very beginning it presented the Operational Executive, that is the Regional Commissioner's Office, with a clear-cut decision to make. If, as sometimes happened, the net probability was very little larger than that of a train accident in the ordinary way, the bomb might be left. Some people have passed, unknowingly, close to some of these. At the higher probabilities, action could be graded accordingly. For example, goods traffic only might be allowed for a period. Only in comparatively rare cases would it be necessary to close the line entirely.

Industry

In industry the oldest example of Operational Research is quality control, as developed since about 1913 by B. P. Dudding in the United Kingdom and W. G. Shewhard in the U.S.A. Nearly all this development has been in mass production industries — dimensional control of machine-made parts, etc., and may not be very applicable to petroleum technology. Recently, however, more and more use is being made of these statistical quality control principles in chemical and similar not-so-very-repetitive processes.

A good example comes from steel rolling. In the rolling of a certain type of billet, inspection costs were high, the proportion of rejects large, and the proportion of customers' complaints disturbing. 100 per cent inspection was carried out at four different points along the bar. A statistical study of these showed, however, that there was a pretty good relationship between measurements at the back end of the bar and at the other three points, also, within fairly narrow limits, the dimensions were held constant over quite long periods. Trouble only came when a mill adjustment, or some similar factor, tended to throw all the qualities off at once.

A system of sample inspection was worked out. In it, only one bar in six was measured and that only at the back end. Inspection for other qualities consisted of a quick visual check. If the measurements were within control limits (narrower than the market specification ones) all bars were allowed to pass. The appearance of a faulty bar, however, was the signal for all bars to be put on one side for later 100 per cent inspection, until conditions became stable again. Conditions were indicated by a system of coloured lights. The net effect was to decrease very considerably the proportion of rejects, decrease by 75 per cent the incidence of customers' complaints and actually to raise the output of the mill. This may sound a little surprising when a sample inspection was substituted for what had been 100 per cent. The physical reasons are too complicated, and perhaps too uncertain, to discuss here, but one of them is worth noting. It is inspection fatigue. Inspectors who very seldom find anything wrong, or, at the extreme, find everything wrong, are apt to lose interest. The monotony is relieved a little when the number of rejects is reasonable.

Several features in common with the Services may be noted. First, there is the statistical and distinctly "research" nature of the studies; second, there is the advisory status of the investigators; third, the object of getting more out of existing resources. There was not, however, in this example, the necessity for special data-collecting, though a certain amount of special observation was made. Industrial data collecting appears in the next one. This often-quoted example is from the boot and shoe industry. The Research Association were seeking methods of "shoeing the population" more efficiently, and in particular needed to find out why stock sizes for women were not always acceptable to customers. They measured, over a period of some years, thousands of women's feet and then attempted to work out the proportion of women that the usual range of stock sizes could reasonably be expected to fit. In so doing they came across a curious but striking fact. The girth increment per size of standard lasts was traditionally accepted at $\frac{1}{4}$ inch. This, however, gave too steep a rate of rise of shoe girth per size, so that at the two ends of the scale a large number of women would, without entirely realizing it, find shoes either long enough but not sufficiently wide, or the reverse. By reducing the increment to 3/20 inch the standard sizes could be made to fit, in theory, several times the number of women. Shoes to the new standard were put on the market as an operational experiment and one sales organization found that it could actually reduce its range of stock sizes from 136 to about 30 and fit nearly twice the number of customers. This example is very interesting. In addition to the features shown by the earlier ones, it is the first one mentioned where Ops Research directly queried a long-accepted practice. This point will be returned to later.

Major development of operational research in industry has been made by the British Cotton Industries Research Association, near Manchester. They have been concerned mainly with efficiency studies in mills, which require intensive data collecting. Their work does not, unfortunately, lend itself to quoting a clear, yet brief, example, since most of the studies were complicated. They have used, however, one method which is well worth noting for determining the average idle time of looms. The conventional way of getting this would be to set time study observers to time the looms with stop watches but one need scarcely be an industrialist to see that in a cotton mill this method would not be very popular, nor, what is much more to the point, would it be very accurate. The method devised by

L. H. C. Tippett was better in both respects. His observers merely walked at intervals through the mill noting the condition of each loom (started or stopped) as they passed. Over a sufficiently large number of observations the proportion of looms stopped clearly tends to become the same as the proportion of idle time. What is more, the probable error of an estimate made in this way can be calculated and cross-checked.

Organization

It is now proposed to sum up, without much discussion, the main features and organization of operational research. First and foremost, though its concern is always with executive affairs, it takes on the nature of applied research in the true sense of the term. Scientific method is apt to be a much-abused word nowadays. Operational research however always tends to use such methods, preferably after they have been established and proved in the laboratory. This perhaps explains why operational research is a fairly recent development. Only comparatively recently have statistical methods become capable of dispensing somewhat with the requirement of perfect reproducibility in experiments. Operations, being mainly human affairs, are never highly reproducible, so until the last few decades "laboratory" methods were probably very little use outside. It is doubtful, for example, whether the scientific methods of their day would have been of much practical value to Genghiz Khan or Henry VIII. It is important, however, for operational research that the operations have some degree of reproducibility. The author suggests that there are three criteria to take into account in deciding whether a particular problem is suitable:—

(*a*) *Is there some degree of repetition?*
(*b*) *Are factual data obtainable?*
(*c*) *Are there some facilities for controlled experiment?*

If the answer to all these is "yes," the problem is, in principle, suitable. By these criteria it is seen that international foreign policy, say, is a less suitable field than washing up. Like many people nowadays the author feels he is asked to do too much of the latter and is glad to report that he has had some success in applying operational research principles to it.

Second, though it is an advisory service, operational research is not similar to an expert one like that, say, of an industrial consultant, who knows beforehand the answers he wants from special knowledge and long experience and is concerned with advising on the best way of getting them. An operational research worker is rarely an expert and always tries to start on a fresh subject with an absolutely open mind. If one can state paper qualifications for operational research, there are only two:—

(*a*) *A training in scientific method.*
(*b*) *Wide interests — scientific and general.*

An operational research worker must, of course, be capable of appreciating the essential technical details of an industrial process that he is called on to study but it is generally a bad thing for him to try to become expert at it. In fact, usually the first thing he does, having been demonstrated the essentials, is to query them. This is often unpopular with executives, because in nine times out of ten a way of doing a thing that has been established from long experience is the best. The queries then merely confirm, after some expenditure of time and money, what the executives already knew. The odd tenth time, however, experience may be at fault and something practically useful be arrived at. It is this continuous element of taking a long-term chance which re-emphasizes the point that operational research is research and not expert advice.

Administratively, operational research sections are small. Unlike technical research, a section generally requires only an office, a calculating machine and access to simple general laboratory facilities. Its organizational requirements, however, are a little more difficult in practice, though simple enough in principle. The most difficult requirement is that the section should have a day-to-day knowledge of executive problems of the kind usually found in the management office rather than in the research department. In spite of this it seems to have been found that the best location in industry, for an operational research section is under the wing of the director of research—at least in a large organization.

Third, a note on statistics. This has cropped up in all our examples but the author does not want to leave the impression that operational research and statistical methods are synonymous —they are not. Statistical method is a necessary but never a sufficient condition for operational research. Much more important is a wide, even possibly shallow, knowledge of scientific research techniques in general, so that those that seem applicable to any particular problem can be selected and more closely studied, if required. Actually both the quantity and the academic level of statistical method needed for operational research are rather low. B. P. Dudding, for example, has stated that "statistical" quality control is only 20 per cent statistics. Others have said —not very happily to the author's mind —that the best definition of operational research is "applied common sense." This is perhaps true but it has an unfortunate implication and it ignores the time element. Scientific methods take time and a cardinal requirement for an operational research worker is that he is given time and facilities that can never be afforded by an executive with many responsibilities.

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Kuwait Crude. Production of crude oil in Kuwait for the month of October, 1950 amounted to 1,622,698 tons. total production for the period January 1, 1950, to October 31, 1950 being 13,719,407 tons.

Persian Crude. Production of crude oil in Persia for the month of September, 1950, amounted to 2,396,000 tons.

"Publicizing Oil." In an article in the November issue of the journal, *Art and Industry*, E. F. Richardson describes the work of Petroleum Films Bureau and Petroleum Information Bureau.

Grain Drying. A film on the storage and handling of combine-harvested grain is scheduled as the main production of Shell-Mex & B.P.'s Farm Service during 1951-2. The film will be ready in the summer.

COUNCIL COMMENTARY

The monthly meeting of Council was held on December 6 with the President in the Chair.

Council learned with regret of the death of Mr Arthur W. Eastlake and stood for one minute as a mark of respect. Mr Eastlake was a co-founder of the Institute with Sir Boverton Redwood and served for many years as Honorary Secretary.

One of the first items of business to be attended to was the election of a President, Honorary Treasurer, and Honorary Secretary for 1951/52. The chair was taken temporarily by Mr T. Dewhurst who proposed that Mr C. A. P. Southwell should be asked to serve for a second year as President of the Institute. This was unanimously and enthusiastically agreed and Mr Southwell, on returning to the chair, expressed his willingness to serve for a second term. The President then nominated Mr George H. Coxon as Hon. Treasurer and Mr Cecil Chilvers as Hon. Secretary and paid tribute to their very valuable work over a period of many years. These nominations were also agreed with acclamation.

Arrangements for the World Petroleum Congress to be held in Holland in Spring 1951 are proceeding apace and the General Secretary reported that a booklet showing time-tables, and particulars of papers, etc., is expected very shortly. Permission has been obtained from the Bank of England to transmit members subscriptions and dues to Holland in bulk. Individual members will, therefore, be able to pay these monies by sending a cheque in sterling to the General Secretary. The A.P.I. has nominated three delegates to the Permanent Council of the World Petroleum Congress—Dr K. A. Mackenzie, Dr E. V. Murphree, and Mr F. S. Clulow.

About three hundred papers have been arranged for discussion or inclusion in the proceedings—over 130 of these coming from America. The President has suggested that photographs and films illustrating developments in the petroleum industry in recent years might well be exhibited and this matter is to be put up to the Organizing Committee in Holland.

The Institute has a number of representatives on outside committees. These representatives have been appointed from time to time as occasion warranted and the list has now grown to a considerable size. It is some time now since Council considered this matter and it has, therefore, been suggested that the whole question should be reviewed.

The General Secretary has prepared a list showing the Committees on which the I.P. is represented and the names of the representatives. This was given general consideration at the meeting but it was obvious that a more detailed examination was necessary. Council members have agreed to study this list and let the General Secretary have any suggestions or comments before next meeting.

It was suggested that the list should be reviewed every year and that I.P. representatives should submit a brief annual report on their activities.

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Iraq Pipeline. The first shipment of pipe for use by the Iraq Petroleum Company in the 560-mile pipeline connecting the Kirkuk field with the Mediterranean seaboard, has arrived at Tripoli. This initial shipment consists of 13.4 miles of 26-inch pipe. Later shipments will be of 30- or 32-inch pipe. The new line, which is scheduled for completion in 1953, will have an annual capacity of more than 18 million tons p.a. of Iraq crude.

DETROIT PUBLIC LIBRARY

PETROLEUM IN PARLIAMENT

Pool Petrol

Asked on November 13 if he would consider raising pool petrol to approximately 80 octane, the Minister of Fuel and Power said: "With the plant now available in sterling refineries, the standard of pool petrol could not be raised to 80 octane without a substantial increase in its lead content; I am advised that this would cause maintenance troubles with British engines. Moreover, the hon. Member's proposal would reduce the total output of motor spirit. For these reasons, as I think he will agree, it would be unwise to adopt it."

Further asked if it was not a fact that the standard of branded petrol before the war was approximately 80 octane, he said: "Before the war we had three grades of petrol—commercial 68 octane, No. 1 grade 75 octane and top grade 80 octane. I am advised that very few vehicles used 80 octane. To raise our petrol even to 75 octane would mean a loss of output."

Fuel Oil Restriction Removal

The Minister of Fuel and Power, stated in a written reply on November 23: "I have decided, after consulting the Petroleum Industry Advisory Committee, that the present arrangements under which new consumers wishing to use gas oil or fuel oil are required to obtain the permission of my Department, are no longer necessary. In future, therefore, the provision of a supply of these fuels will be a matter for arrangement between the consumer and his oil supplier, and my prior permission will not be required."

Town Gas from Petroleum

On December 4 Mr Geoffrey Lloyd asked the Minister of Fuel and Power whether he could make a statement about the production of town gas by the catalytic gasification of petroleum oils and its possible contribution to the present shortage of coal and coke.

Mr P. Noel-Baker said: "At a research meeting of the Institution of Gas Engineers a few days ago, some advance particulars were given of experimental work which is being conducted by one of the area gas boards, on a process of catalytic gasification of petroleum oils. I regret that it is too soon to assess the practical value of this work, if the present experiments succeed. The successful development of the process may well lead in due course to some saving in the coal and coke used by gasworks, but I am afraid that this is unlikely to be of appreciable help during the present winter."

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U.S. PIPELINES

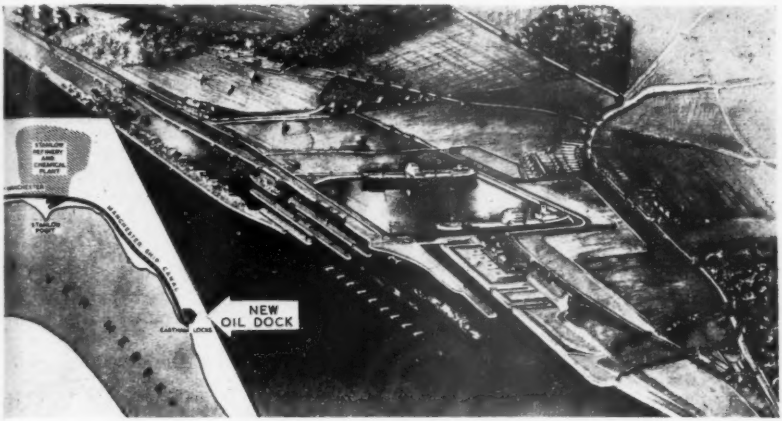
On January 1, 1950, the total mileage of crude oil and petroleum product pipelines in the United States was 152,814, consisting of 92,254 miles of trunk lines and 60,560 miles of gathering lines, the total comparing with 127,351 miles in 1941, and 90, 170 miles in 1926.

The mileage of pipelines at the beginning of 1950 by size of pipe was:

Size, internal dia. inches	*Trunk Lines—Miles Crude oil*	*Products*	*Gathering Lines —Miles*
2	—	—	17,249
3	—	—	9,655
Below 4	1,233	391	—
4	2,768	1,366	20,940
6	12,254	6,696	9,224
Above 6	—	—	3,492
8	27,780	9,979	—
10	13,500	1,628	—
12	9,027	817	—
Above 12	4,811	4	—
	71,373	20,881	60,560

These figures are extracted from Bureau of Mines Information Circular 7585, which also gives details of mileages by states and comparisons for 1926, 1931, 1936, 1941, and 1949.

DOCK FOR SUPER-TANKERS



Plan of the new Eastham oil dock

The largest oil dock in Britain is now under construction in a 175-acre site at Eastham in Cheshire, at the beginning of the Manchester Ship Canal.

Work began on the project in October 1949, the dock being scheduled for completion by mid-1952.

Final design for the dock provides four berths in the form of a square with sides 900 ft in length, each berth to accommodate a tanker of 28,000 d.w. tons or even 30,000 d.w.t. The dock itself will cover 18½ acres and is designed for more than 40 ft depth of water. From each berth discharge facilities will feed a 16-inch diameter pipeline system to be laid along the canal bank to Stanlow refinery, a distance of seven miles.

Entry to the new dock will be by an entrance lock 800 ft long by 100 ft wide. The three sliding lock gates will be electrically operated.

At present work on the dock is at the excavation stage and it is estimated that a total of 3½ million cu. yards of rock and earth will have to be removed by a conveyor belt system.

Concreting is due to begin shortly, when a central mixing plant will provide the 250,000 cu. yd. of concrete needed.

(Shell photograph)

Excavation of the new outer lock-gate "camber," or recess, for the new lock. This has reached the maximum depth of over 80 ft. below the original ground level.

AROUND THE BRANCHES

FAWLEY, LONDON, NORTHERN, SCOTTISH, SOUTH WALES, STANLOW, TRINIDAD

Fawley Branch

At the meeting held on November 15 Dr E. M. Dodds, of the Technical Sales Group of Anglo-American Oil Co., gave an interesting talk entitled "Some aspects of the diesel cycle." For the benefit of those of his listeners who were not very familiar with the diesel engine, Dr Dodds first showed a film demonstrating, very simply, the basic difference between the diesel cycle and the petrol, or paraffin cycle. He then elaborated some of the points made by the film and finally answered a number of questions.

Dr F. Mayo was in the chair.

London Branch

On November 20 at Manson House the second in the series of papers Petroleum in Industry was delivered by A. J. Goodfellow, former chairman of the Branch, on the subject of "Paints, Plastics and Rubber." N. E. F. Hitchcock, London Branch Chairman, was in the chair.

The lecturer began by reviewing the part which petroleum solvents have come to play in the manufacture of paints and the more modern development of synthetic petroleum solvents for lacquers. From there he went on to discuss the plastics industry, briefly explaining some of the complicated chemical processes involved and giving a picture of the extraordinarily wide field of application of plastics today. A number of interesting graphs gave an idea of the scale of plastics production, particularly in the United Kingdom and the United States—it was noteworthy that British production of plastics per head of the population was of much the same order as the United States figure. The lecturer also gave some idea of the immense future of synthetic plastics, in which the part played by petroleum derivatives would obviously be of overwhelming importance. The last section of the paper dealt with the rubber industry, in which petroleum solvents have virtually displaced the coal tar solvents of earlier days and ended by an interesting survey of the development and future of synthetic rubber derived from petroleum. The paper made it clear that the very wide field of application of the solvents and synthetic products in the three industries concerned gave these products an importance and interest which are out of proportion to the small percentage they form of the total output of products from crude petroleum.

A film dealing with the chemistry and application of a number of synthetic products of petroleum followed the paper.

A vote of thanks, proposed by A. W. Deller, was carried enthusiastically and the speaker was afterwards entertained to the customary dinner in the Bolivar restaurant.

London Branch Dance

The Branch's first major winter social function, a buffet dance, was held on the evening of December 1 at Manson House, which was transformed for the occasion in a most pleasing and cheerful manner. It was hard to recognize the hall, with its flowers and the band on the dais, as the room where normally so much profound wisdom on petroleum subjects is heard. The London Branch were honoured by the presence of the President of the Institute, Mr C. A. P. Southwell and Mrs Southwell, in addition to a number of other members of Council.

A well-stocked bar and a very adequate running buffet provided the right background for the dancing, to the

music of Eric Lambert's band—for which the 120 people present comfortably filled the floor. In the course of the evening N. E. F. Hitchcock, chairman of the London Branch, briefly introduced the President, who aptly summed up the feelings of those present in expressing the thanks of the guests for an enjoyable evening, particularly mentioning the efforts of the general secretary of the Institute, D. A. Hough, in making the detailed arrangements.

At midnight "Auld-Lang-Syne" and "God Save the King" ended a very pleasant evening, and it is hoped that this good beginning will be followed by many similar events.

Scottish Branch

Before James Young founded the Scottish shale industry a hundred years ago, lamp oil cost 8s or 9s a gallon. Paraffin from shale originally sold at the comparatively low price of 5s a gallon in the 'fifties, but with the importation of cheap oils from America and Russia, the price of paraffin had dropped in Glasgow to 4d a gallon, barrels free, by 1894. The native shale industry was almost driven out of business and survived only by the most intensive improvements in technique.

These and many other interesting facts about the early days of the oil industry in Scotland were given in a paper on the "Distribution of Petroleum Products," read to the Scottish Branch of the Institute of Petroleum on November 30 by T. W. Lyle, general manager of Scottish Oils and Shell-Mex Ltd.

In speaking of the present day, Mr Lyle mentioned the four sources from which petroleum products enter the distributive machinery in Scotland—the shale oil refinery at Pumpherston, the refineries at Grangemouth, Ardrossan, and Dundee, which process imported crude oil, the importation from England of certain lubricants and special spirits, and the direct importation of products from overseas refineries at the ocean installations on the Clyde and the Forth. Mr Lyle then described how the various products passed through the chain of supply to the ultimate consumer.

James Colville proposed a vote of thanks to Mr Lyle for his interesting lecture.

J. T. Guthrie, who acted as chairman in the unavoidable absence of Mr Robert Crichton, was thanked for his services on the call of James Scott.

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PERSONAL NOTES

C. M. Vignoles, O.B.E., M.Inst. Pet., has been appointed a director of Shell-Mex and B.P. Ltd. Mr Vignoles, who joined the Royal Dutch - Shell in 1924, served in the Far East in the early part of his career. He became Eastern Area manager of Shell Petroleum Co after the war.

Dr C. G. Williams, F.Inst.Pet., director of research, Thornton Research Centre, "Shell" Refining & Marketing Co Ltd., has been elected a member of the Automobile Division Council of the Institution of Mechanical Engineers.

Colonel H. C. Smith, C.B.E., was elected President of the British Tar Confederation for the year 1950-1 at the recent A.G.M. of the Confederation.

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Oil and Steel, the latest memorandum compiled by Petroleum Information Bureau, deals with the part played by steel in the manufacture of petroleum equipment and with the growing use of oil in steel processing. Copies from P.I.B., 29 New Bond Street, London, W.1.

CORRESPONDENCE

Fuel and Energy

To the Editor,
Institute of Petroleum Review.
Sir,

In the technical press and elsewhere there have been a number of papers recently dealing with world and continental overall fuel consumptions. In many of these a useful picture is given but none goes far enough or considers the subject satisfactorily in relation to all fuels and the different grades required for particular industrial processes.

In Europe, for example, the greater amount of fuel oil requirements will have to be imported, either in the form of crude oil or refined products, but such conditions do not apply to solid fuel. It would be desirable for a fuel survey to be made, including the total fuel consumptions, the resources available, and the different qualities of these fuels to maintain industrial production. It would be shown by such a survey that while large quantities of fuel are available, there is likely to be in the future a shortage of particular grades for specialized industrial processes. In this connexion, fuel oil should be complementary to solid fuel and the survey would indicate those industries where the maximum benefit could be obtained by the use of oil. This consideration should, of course, be linked with the quality and grades of oil which will be produced by the refineries and the qualities which will be demanded by industry.

In the U.K., the U.S.A., and elsewhere, it has been shown, for example, that the use of oil for certain high temperature processes is economic in spite of large supplies of indigenous fuels being available. There are, however, certain demands as far as quality is concerned in these applications and this must be borne in mind when considering where and how oil can be used to obtain maximum benefit to the overall fuel position.

Further, the geographical relation of the oil refineries and ports of entry of refined products to the sources of indigenous fuels must be considered in order that transport and other costs may be taken into account so as to utilize both solid and liquid fuels as efficiently as possible in the right places. It might be shown in this connexion that, while from a technical viewpoint the use of fuel oil in place of solid fuel shows no advantage, in certain instances from an economic angle, it might be preferable to use fuel oil in place of solid fuel. An attempt could be made to evaluate the relative values of the fuels by a consideration of the energy consumptions required to transport them.

I am not aware of a complete survey of the fuel needs divided into different industries and processes where it is required and the fuel resources divided into the geographical areas with the different qualities, which are available having ever been published. Before we can consider the fuel position of the world it is essential that we have this information in as accurate a form as possible.

Food and fuel are two basic fundamental requirements of civilization and the more these are linked together the better the community will be served. The use of fuel in, for example, preserving the results of increased food production and making the harvesting of crops possible in spite of inclement weather does in fact increase the productivity of the land. This is a very important point in view of the rapidly increasing population of the world and the necessity to secure the maximum agricultural production if we are not to suffer from a shortage of food in the future.

Undoubtedly the fuel consumption per head of population is a convenient

"yardstick" to indicate the level of economic development and the standard of living attained by any given community. I would like, however, to suggest that great care must be taken in making any comparisons due to the variations in climatic and geographic conditions. As an example, the fuel consumption per head of population in the U.S.A. is often compared with that in other countries, the figure for U.S.A. being the highest in the world, to show the progress achieved and development possible in these other countries. This is fundamentally wrong as an equivalent standard of living can often be obtained in these other countries with a much lower fuel consumption due to the different ways of life which apply. To take one point, the Americans require a standard of comfort with indoor temperatures of the order of 70°-72°F, conditions which would be intolerable and uncomfortable to a large proportion of the population of Europe. The appliances used for the production of heat from fuels vary considerably and must be taken into account, as well as the technical development which is continually taking place. Therefore, we must be very careful how overall fuel consumption figures are interpreted.

In respect of any particular community or country, comparison of fuel consumptions per head of population at different times does, of course, give a very good idea of the progress which has been achieved during the time considered.

In contra-distinction to food, fuel is an ever diminishing resource and all our efforts should be directed to using all the fuel we consume in the most efficient way and in the right places so that we obtain the maximum benefit from the least possible amount we use.

Yours faithfully,

G. F. J. MURRAY.

45 Temple Road, Epsom, Surrey.
October 9, 1950.

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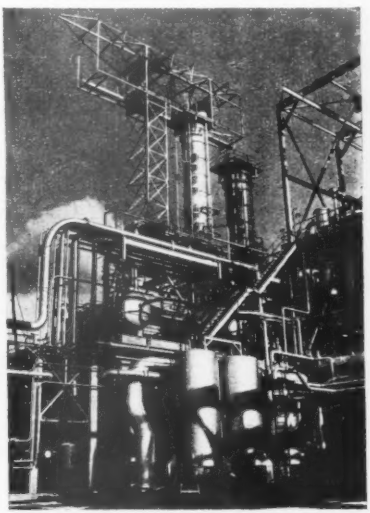
NEW SHELL HAVEN PLANT IN OPERATION

The new plant at Shell Haven refinery recently came on stream six weeks ahead of schedule. At present production is confined to one distillation unit and ancillary facilities, whose output is at the rate of 1,450,000 tons a year. The full refinery, scheduled for completion in 1952, will have an output capacity of 2 million tons a year.

Other facilities now under construction include a doctor treating plant for the sweetening of 1,300 tons/day of straight-run gasoline from the distilling unit, a 1,200 tons/day reforming unit, due for completion by mid-1951. Installation is also planned of a feed preparation plant having a design capacity of 2,500 tons/day for production of bitumen stock to be handled by the existing refinery.



Columns C.4 and C.5 of the Shell Haven distillation plant.

WORLD PETROLEUM CONGRESS MEMBERSHIP DUES

Permission has now been obtained from the Bank of England for the General Secretary of the Institute of Petroleum to accept sterling cheques for membership dues for the Third World Petroleum Congress.

This permission only applies to men or women who are engaged in the petroleum or allied industries, and consequently, only the sum of £2.10 per person can be accepted. All that is needed therefore, for members of the Congress who have already sent in their forms, is to send a cheque for £2.10. Members who have not yet applied for membership should send membership application form, together with a cheque for £2.10. Cheques and application forms should be sent to the General Secretary, at 26 Portland Place, London, W.1.

Membership dues in respect of wives, or friends not connected with the petroleum industry have to be deducted from personal travelling allowances. and it is therefore not possible for such applications to be dealt with by the Institute. Arrangements must be transacted in the ordinary way through the banks of the individuals concerned.

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RADIO-ISOTOPE INSTRUMENTS

A useful brochure summarizing and illustrating equipment available from British sources for radio-isotope techniques in research, industry, and medicine has been published by the Scientific Instrument Manufacturers' Association in collaboration with the Atomic Energy Research Establishment.

Copies of this 44-page brochure, which is edited by Dr D. Taylor and A. G. Peacock and has a foreword by Sir John Cockcroft, are obtainable by interested parties free on application to SIMA at 17 Princes Gate, London, S.W.7.

U.S. PETROLEUM REFINERIES

On January 1, 1950, there were 367 petroleum refineries in the United States, compared with 375 a year before. In spite of the decrease in number the total crude-oil throughput capacity had increased from 6,438,995 to 6,696,300 barrels daily. Details from U.S.B.M. Information Circular 7578 are:

Refineries	January 1 1950	1949
Operating:		
Number	320	336
Crude capacity, b/d ...	6,222,998	6,230,505
Shut Down:		
Number	47	39
Crude capacity, b/d ...	473,302	209,490
Total:		
Number	367	375
Crude capacity, b/d ...	6,696,300	6,438,995
Building:		
Number	2	3
Crude capacity, b/d ...	145,600	341,500
Cracking Capacity, b/d:*		
Operating	1,732,241	1,638,783
Shut down	88,442	76,490
Total:		
Reformed	307,007	290,275
Thermal	784,621†	821,462
Catalytic	729,055	603,536
Building	94,045	136,602

* In terms of cracked-gasoline production.
† Includes some reformed and catalytic.

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CORYTON REFINERY

In his statement at the recent Annual General Meeting of Powell Duffryn Ltd. the chairman said that agreement had been reached with Socony-Vacuum Oil Co. Inc. of America to erect a refinery at Coryton, which is to be operated by the Vacuum Oil Co., a British company, to be jointly owned by Powell Duffryn and Socony-Vacuum. This project will cost not less than £3½ million over the next few years.

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WORLD POWER CONFERENCE

Sir Vincent de Ferranti, M.C., representing the British Standards Institution, has succeeded Sir Harold Hartley as Chairman of the British Committee of the World Power Conference. Vice-Chairman is Mr Harold Hobson and Honorary Treasurer Col. C. M. Croft.

FORTHCOMING MEETINGS

INSTITUTE MEETINGS

The I.P. Safety Codes. Papers by members of the I.P. Engineering Committee: General Considerations by E. J. Sturgess; Their application to production, by H. de Wilde; Their application to refining, by Dr F. Mayo; Their application to marketing, by R. L. Sarjeant. At 26 Portland Place, London, W.1, 5.30 p.m. (*tea* 5 *p.m.*), January 10.

Petroleum Waxes. T. C. G. Thorpe. At 26 Portland Place, London, W.1, 5.30 p.m. (*tea* 5 *p.m.*), February 14.

Fawley Branch

Annual General Meeting and Film Show. At Esso Recreation Club, Holbury, Southampton, 7.30 p.m., January 17.

Oil from the Desert. C. A. P. Southwell. At Esso Recreation Club, Holbury, Southampton, 7.30 p.m., February 15.

London Branch

Petroleum in Industry, III—Steel. T. C. Bailey and H. J. Knight. At 26 Portland Place, London, W.1, 6 p.m. (*tea* 5.30 *p.m.*), January 23.

Petroleum in Industry, IV—Textiles. F. McLaren. At 26 Portland Place, London, W.1, 6 p.m. (*tea* 5.30 *p.m.*), February 21.

Northern Branch

Annual General Meeting. Address by C. A. P. Southwell, M.C. At Engineers' Club, Albert Square, Manchester, 6.30 p.m., January 16.

The Background of Performance Testing of Lubricants. A. Prizeman. At Engineers' Club, Albert Square, Manchester, 6.30 p.m., February 20.

South Wales Branch

The Selection of Lubricating Oils for Industrial Purposes. H. E. Priston. At Britannic House, Llandarcy, 5.30 p.m., January 16.

Annual General Meeting. At Britannic House, Llandarcy, 5.30 p.m., February 6.

Stanlow Branch

Refinery Considerations. M. A. L. Banks. At Grosvenor Hotel, Chester, 7.15 p.m., January 17.

Influence of Fuel Characteristics on Behaviour of Compression Ignition Engines. C. D. Brewer and B. H. Thorp. At Grosvenor Hotel, Chester, 7 p.m., February 14.

OTHER SOCIETIES

The Application of High Speed Centrifuges in the Chemical and Process Industries. R. H. Dolton. Chemical Engineering Group, Society of Chemical Industry. At Burlington House, London, W.1, 5.30 p.m., January 16.

Low Temperature Carbonization: Past Present and Future. G. S. Pound. Institute of Fuel. At The University, Sheffield, 6.30 p.m., January 17.

Combustion Control. J. E. O'Brien. Institution of Heating and Ventilating Engineers. At Gas Lecture Theatre, Town Hall, Manchester, 6.30 p.m., January 26.

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GAS TURBINE METALS

The Iron and Steel Institute are to hold a Symposium on High-Temperature Steels and Alloys for Gas Turbines on February 22-23. Meetings will be held in the lecture theatre of the Institution of Civil Engineers at 10 a.m. and 2.30 p.m. Members of the Institute of Petroleum are invited to attend and may obtain full details from the Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1.

On February 20 the fifth Hatfield Memorial Lecture on "Turbine problems in the development of the Whittle engine" will be given by Air-Commodore Sir Frank Whittle, K.B.E., C.B., in the York Hall, Caxton Street, Westminster, at 8.30 p.m. Admission is by ticket from the Iron and Steel Institute.

PHOTOGRAPHY IN COMMERCE

At the recent exhibition of photographs organized by the Institute of British Photographers, the petroleum industry was much in evidence. Thus, members of the Shell Photographic Unit had 18 pictures in the Commerce and Industry Section and one colour print in the Colour Section. In the first Section most of the exhibits by Shell artists were concerned with tankers, refinery plant, storage spheres, etc., mostly presented from unusual viewpoints and so Derrick V. Knight's *Venezuelan Belle* was a striking and attractive contrast. In the same section Raymond C. Wilson had two pictures, one of a gas separator and the other of a tanker discharging, both of Anglo-Iranian Oil Co., while the spheroids at Stanlow were shown by W. Robson. Also C. Cadwallader (Shell) had photos of a grasshopper's head and almond blossom in this section and three prints and a transparency in the Colour Section.

Throughout the exhibition there were many excellent examples of the applications of photography in commerce and industry.

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APPOINTMENTS VACANT

Senior Petroleum Engineer: Independent Canadian oil company, with headquarters in Calgary, has opening for Senior Petroleum Engineer particularly experienced in Reservoir Engineering and Production Practices.

No one with less than seven years experience in the industry need apply. Give synopsis of education, training and experience. Supply recent photo if possible. All replies will be held in strict confidence. Write to: 206 Lougheed Building, Calgary, Alberta.

ASSISTANT TO SUPERINTENDENT of oil stocks and movements department required by petroleum refinery in North-West England. Practical experience of gauging, pumping, and loading petroleum products essential. Applicant to state salary required. Non-contributory assurance scheme in operation. Apply Box No. 1057.

An Oil Refinery in Pakistan has a vacancy for an experienced **CHEMIST.** He should be familiar with refinery plant including distillation, cracking and solvent extraction. He should be a science graduate of a British university. A three years' agreement on good salary is offered, renewable at mutual consent, and passage, partly furnished accommodation and medical attention are provided free. Apply in writing stating qualifications, age and experience to Box No. 1056.

FUEL TECHNOLOGIST required by petroleum refinery in North-West England. Applicants must have good academic qualifications in applied chemistry or industrial experience as fuel economy officer. Successful applicant will be directly responsible to management for technical efficiency of fuel and power distribution and utilization methods, and will be required to co-operate with producing and consuming departments to achieve maximum overall thermal efficiency and lowest cost for fuel (oil) and power (electricity.) Commencing salary £600-£800 per annum, dependent on qualifications. Non-contributory assurance scheme in operation. Apply Box No. 1058.

SAFETY OFFICER required by petroleum refinery in North-West England. Successful applicant will be directly responsible to management for upkeep of safety records for all plant and equipment, institution and operation of safe practice routines in operation, and maintenance and technical advice to Safety Committee. Experience in similar capacity or wide knowledge of legal requirements, industrial safety codes and heavy chemical engineering practice essential. Commencing salary £600-£800 per annum, dependent on qualifications. Non-contributory assurance scheme in operation. Apply Box No. 1059.

A young **TECHNICAL ASSISTANT** is required by a major Oil Company for its Technological Department at Head Office. Good education and Honours B.Sc. degree or A.R.I.C. are essential qualifications. Applicants should preferably have some acquaintance with lubricating oils and greases, their manufacture, and methods of test. Salary will be commensurate with qualifications and experience. Conditions of employment include pension and sickness benefit schemes. Applicants should write giving full particulars, quoting reference (X.1603) to Box No. 1060.

U.K. PETROLEUM STATISTICS

An interesting booklet has recently been issued by the Petroleum Information Bureau on behalf of the U.K. Petroleum Industry Advisory Committee and giving statistical facts concerning the U.K. petroleum industry.

For the years 1938, 1948 and 1949 figures are given of consumption of various products and in some cases details of the amounts used in various industries, of production of petroleum products in the U.K. from imported and from indigenous raw materials. It is of interest to note that total production of all products rose from 2,391,722 tons in 1938 to 6,163,790 tons in 1949 while in the same period consumption increased from 8,990,686 to 13,839,727 tons.

Copies are available from the P.I.B. at 29 New Bond Street, London, W.1.

"THIS WORLD OF OIL"

Under the above title, the Public Library's Committee of the Borough of Ealing recently held an exhibition in its Central Library. By means of photographs and models all phases in the search, the winning, and the manufacture of petroleum and its products were illustrated and samples of a wide variety of products and articles manufactured from petroleum products were exhibited.

The photographs and models were provided by the Anglo-American Oil Co. Ltd.

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Insulating Bricks. The Kimolo (Moler) Technical Handbook No. 1 presents information about insulating bricks made of diatomaceous earth. Copies from Cellactite and British Uralite Ltd, Terminal House, 52 Grosvenor Gardens, London, S.W.1.

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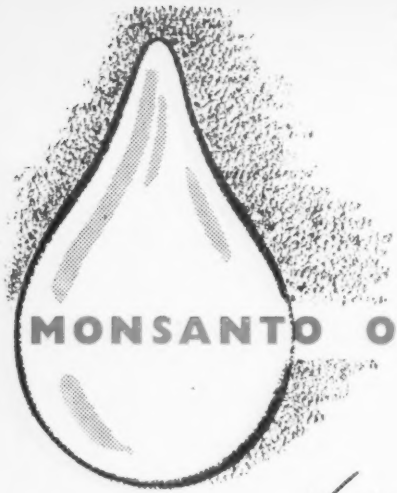

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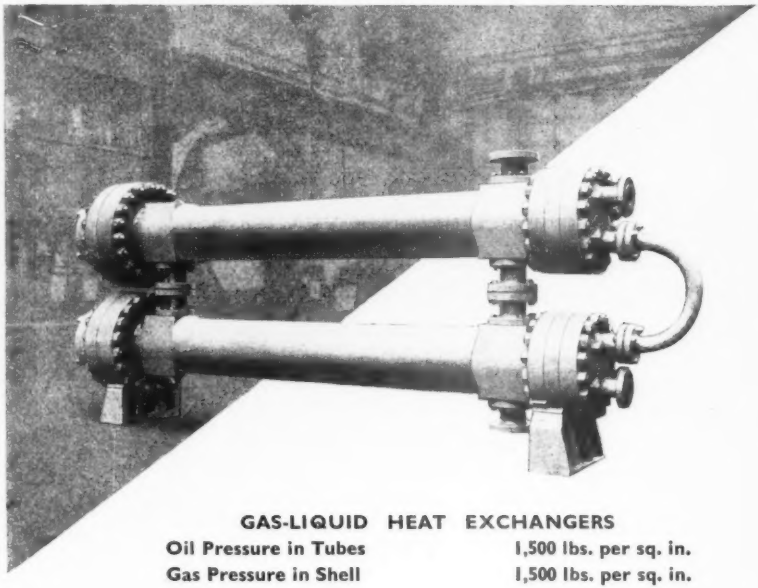

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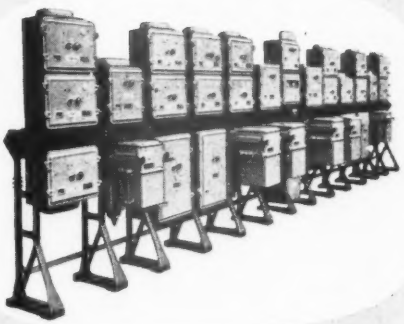

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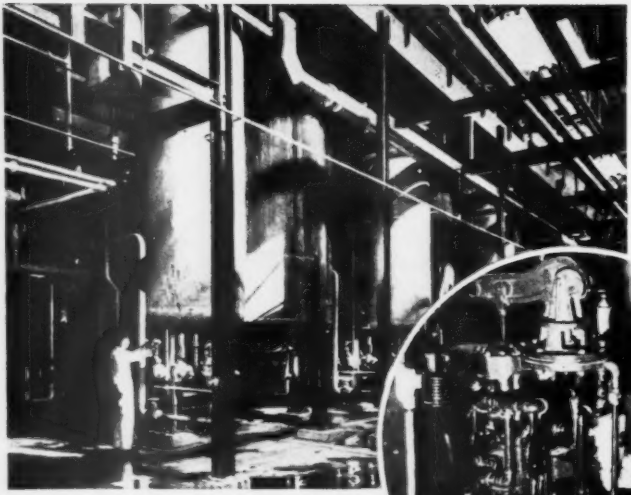

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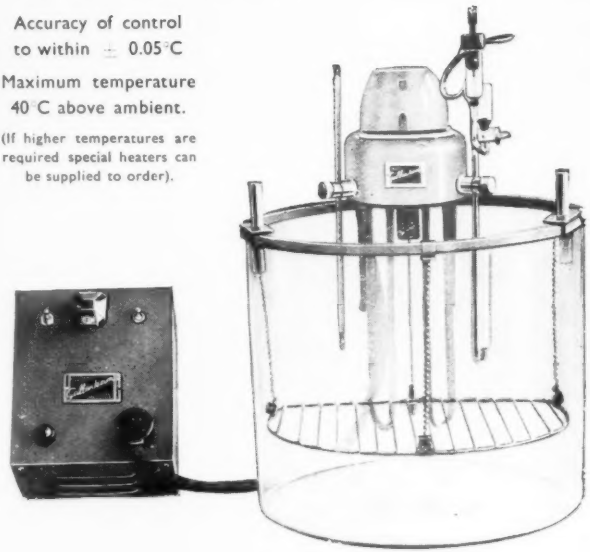

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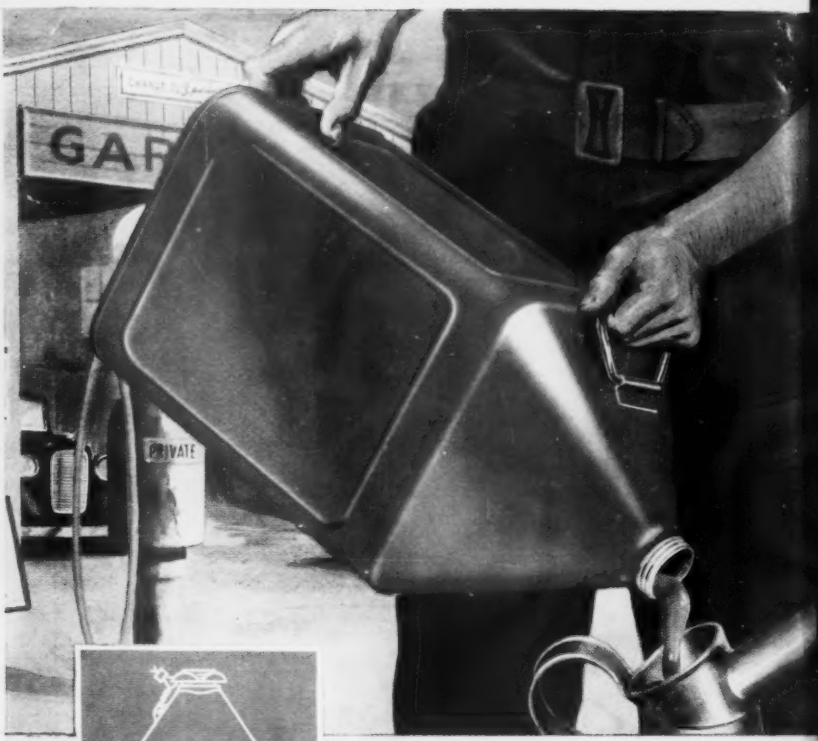

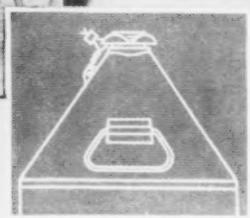

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